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AVIAN POLYSPECIFIC CLUTCH SIZE AS BIOINDICATORS OF ECOLOGICAL CONDITION OF THE AREA

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Abstract:

The present study deals with general trends in clutch-size of local birds and examined some of the hypotheses regarding the adaptive significance of the timing of breeding and variations in the clutch size, that have been put forth as possible explanations with in seasonal variation of average clutch-size of the birds. In the present work, recorded clutch size of 15 bird species belong to 10 families of 5 different orders most of them were passerines. Studies on clutch size helped to study life history traits of various birds, particularly Brahminy Myna *Sturnus pagodarum* and Indian Shikra *Accipiter badius*. Whereas clutch sizes of other birds provided an approximate measure about birth rate of that species. Clutch of each bird was observed approximately constant for that species. Further, this available information might be beneficial in future for detail study of that particular bird species from the local area. This study was carried out from July 2016 to June 2018 and simultaneously confirmed thereafter till June 2019.

Key words : Clutch size, coefficient of variation, hatchling, nidicolous, atricial, precocious.

Materials and methods:

The study was carried out on local residential birds, for the study and record of clutch size field visit were carried out during breeding season, nest were located by observing behaviour of birds carrying nesting material and searching behaviour. During breeding season birds shows courtship, mating, nest building or renovation and incubation helping to locate the nest. The observations made regularly with binoculars or by naked eyes in some cases. The chief object of the present study was to obtain the information about general trends in clutch-size of birds from local area and to report frequencies of the various clutch-sizes observed as well as other natural history notes. Field survey was carried out from July 2016 to June 2018 and simultaneously confirmed thereafter till June 2019.

During these studies, we accumulated data on clutch-size of various birds and other aspects of natural history such as egg laying period, role of sexes in incubation and incubation period by birds. We determined a clutch's starting date at least one visit during the laying period of most of the birds and clutch-size by at least two or more visits following the completion of laying. A clutch was assumed to be complete and incubation to have begun when no new eggs were recorded during a period of three days. Once the nest and nesting site of a bird located, we concentrated over it till first egg laying. Later on nests were visited at one or two day intervals to obtain clutch-size of the bird.

Results:

During our study period, we recorded clutch-sizes for 15 bird species belonging to 5 orders which include 10 families, most of them are passerines. Most of the clutches were started between March and July. In local residential birds the average clutch of different species ranges from 2 to 8, but a normal clutch of one is rare, if present, it may be due to loss of other eggs. A clutch of 3 to 4 is probably the most frequent in the local birds (Table 1).

Table 1- Frequencies of clutch-size of bird species in local area.

SPECIES	n	CLUTCH-SIZE								
		2	3	4	5	6	7	8	Mean	SD
A) Galliformes a) Phasianidae 1) Peafowl *Pavocristatus*	10	2	4	3	1	0	0	0	3.30	
2)JungleBush-Quail *Perdicula asiatica*	6	0	0	0	1	1	2	2	6.83	
B) Psittaciformes b) Psittacidae										

3) Parakeet *Psittaculakrameri*	8	0	0	6	1	1	0	0	4.38	
C) Columbiformes c) Columbidae 4)Blue rock Pigeon *Columbalivia*	17	13	4	0	0	0	0	0	2.24	
5)Little BrownDove *Streptopeliasenegalensis*	9	9	0	0	0	0	0	0	2.00	
d) Charadridae 6)Yellow-wattled Lapwing *Vanellusmalabaricus*	6	0	2	4	0	0	0	0	3.67	
7)Red-wattled Lapwing *Vanellusindicus*	3	0	1	2	0	0	0	0	3.67	
D)Ciconiformes e)Accipitridae 8)Shikra Accipiter badius	13	9	4	0	0	0	0	0	2.31	$\pm$ 0.53
E) Passeriformes f) Corvidae 9) House Crow *Corvussplendens*	32	0	0	29	3	0	0	0	4.41	
g) Muscicapidae 10)Common Tailorbird *Orthotomussutorius*	3	0	1	2	0	0	0	0	3.67	
11) Indian Robin *Saxicoloidesfulicata*	5	2	3	0	0	0	0	0	2.60	
h) Sturnidae 12) Brahminy Myna *Sturnuspagodarum*	36	1	7	28	0	0	0	0	3.75	$\pm$ 0.49
13) Common Myna *Acidotherestristis*	19	0	0	16	3	0	0	0	4.16	
i)Pycnonotidae 14)Red-ventedBulbul *Pycnonotuscafer*	7	1	2	4	0	0	0	0	3.43	
j)Passeridae 15) House Sparrow *Passerdomesticus*	27	0	11	14	2	0	0	0	3.59	

During study period we observed large number of eggs (n = 135) in nests (n = 36) of the *Sturnus pagodarum*. Most frequent clutch size was 4 in 28 nests, followed by 3 in 7 nests and 2 in 1 nest. Thus average clutch size of *S. pagodaram* was 4 with coefficient of variation 3.75 $\pm$ 0.49 (Mean $\pm$ SD). Both Male and female sexes shared in nest building, incubation and feeding of their hatchlings. The egg laid by female day after day, the incubational studies of marked eggs showed 21.4 $\pm$ 2.72 (Mean $\pm$ SD) in 2017 and 23.0 $\pm$ 2.61 (mean $\pm$ SD) days in second year 2018 of the study period. Clutches hatched over period of 3 to 4 days and the hatchings were atricial and nidicolous.

Eggs colour of *S. pagodarum* was unmarked bluish pale, constant in all observed nests. Nests containing small clutches (2 or 3) were very less in number (8), it may be due to poor nest site selection, easily observable to the predator, less height from the ground caused poor protective measures. Besides, male visits to such nests also observed to be less in contrasts to others.

Besides we also studied *Accipiter badius* for clutch size and various other aspects of natural history. For which 13 nest with 30 eggs spotted in the local area. Of which 9 nests with 2 eggs and only 4 nests with 3 egg, thus most constant clutch was 2 to 3 with coefficient of variation 2.30 $\pm$ 0.53 (mean $\pm$ S.D.), with colour of egg at laying was whitish blue but few days after it was changed to faintly speckled white after incubation. Most eggs were observed in early April of the study period, egg laid by 24 hr. interval continuously, but in few cases II or III eggs irregularly after 2 days interval until clutch completion. Both male and female individuals took part in their domestic duties, except incubation, only female incubated eggs and male provide food and protection to the young ones and females.

When any intruder such as House Crow *Corvus splendens*, Jungle Crow *Corvus macrorhynchos*, and Black Kite *Milvus migrans* entered in air space towards eggs, protecting male flew straight at them, chasing them and evicted the predators.

The incubation period of was 36 days, whereas hatching sequence of egg took place at 24 hrs. While, third egg hatched after 36 hrs. But in most cases second and third egg unhatched due to unknown reasons, or may be due to infertility of egg, not a single egg containing died embryo observed in the nest. Although the nest of these birds was a loose platform of twigs and sticks

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but it was very clean before and after hatching of eggs. In the study area hatching of eggs correlated with the period of prey abundance.

Discussion:

Anders P Moller et al (2014) reported that nest structures built to support and protect eggs and / or offspring from predators, parasites and adverse weather conditions, parents decide sites and quantified relationship between clutch size and nest size, using as exhaustive database of 116 slopes estimate based on 17472 nest of 21 species. Meena Kumari et al (2016) studied clutch size and characteristics of spotted munia and reported 24 clutches, with average 5-7 eggs with mean 6.25$\pm$0.51, Clutch size was probably the most commonly evaluated of all – life history traits in studies of avian reproduction. It was easily obtained and provided a measure of function that broadly applicable to comparison with in and among species (Stearns 1992, Roff 2002). Further more, clutch size, along with the date of clutch initiation is useful for understanding investment strategies of seasonal breeders that have broad geographic ranges. Morton and Peretra (2004) recorded clutch sizes for several birds, mostly passerines and reported with frequencies of various clutch sizes, nest sites and natural history traits of birds at Tioga Pass. Floyd E Hages (2014) presented data on the breeding season and clutch size of 63 species of birds at Sapucai based on 454 clutches of eggs.

In the present work, recorded clutch size of 15 bird species belong to 10 families of 5 different orders most of them were passerines. Studies on clutch size helped to study life history traits of various birds, particularly Brahminy Myna *Sturnus pagodarum* and Indian Shikra *Accipiter badius*. Whereas clutch sizes of other birds provided an approximate measure about birth rate of that bird species. Clutch of each bird was observed approximately constant for that species. Further, this available information might be beneficial in future for detail study of that particular bird species from the local area.

Various factors influencing avian clutch size have been discussed by many workers (Lack 1954, Ricklefs 1980, Gibbons 1987, Amundsen and Slagsvold 1991, Weibe and Bortolotti 1994, Saether 1994, Palomino et al 1998, Aziz A and Mustafa Y 2010), many of these observers hypothesized that population density or population density relative to food supply is low; there should be more food available to raise young, and clutch size should be larger, G. Mustafa Shah et al (2008) discussed observations made on egg laying, egg parameters and clutch size in Mallard *Anas platyrhynchos*, egg laying season extended from early March to early June, and he further noted April was the peak egg laying month and reported average clutch size was to be 8.27 ($\pm$ 2.23).

In the local study area it was observed that birds constructed nests in a habitat where there was availability of large amount food to feed to the young ones after hatching. Hatching period of eggs of Brahminy Myna *S. pagodarum* and Indian Shikra *Accipiter badius* correlated with the availability of large amount of insect food to the hatchlings and developing young ones of these bird species. Eggs of most of the bird species hatched June – July months, during which there was availability of food supply to the hatchlings.

Nest size is monogamous passerines has recently been hypothesized to be a sexually selected signal of parental quality. Females may be able to assess male parental quality from their participation in the nest – building process or from nest characteristics and then adjust clutch size according to male parental quality or his willingness to invest in reproduction (Soler et al 1998)

The present investigation also support this hypothesis, on the basis of studies on *S. pagodarum* and *Accipiter badius*, in which both male and female actively participated in various parentage activity to achieve large breeding success in the local study area.

In the black Wheatear *Oenanthe leucura*, nest size was related to parental quality (Morena et al 1994). In the barn Swallow *Hirundo rustica*, nest size was related to male contribution in nest building, and nest size was related to the number of eggs laid by a female during the breeding season (Soler et al 1998a). In the Rufous bush Robin *Cercotrichas* *galactotes*, nest size was positively related to the size of prey males carried to the nest to feed the young (Palomino et al 1998).

In *S. pagodarum* some nests contained single egg due to loss of other eggs by various factors, male visits to the nesting was observed to be less, besides such behaviour was also observed in yellow wettled Lapwing, in which eggs were infected only one egg was in proper condition containing embryo, whereas all other eggs were infected and broken due to unknown regions, parents at the nest were not observed for number of days of observations.

In the Magpie *Pica pica* nest size was related to laying date (Soler et al 1995). Moreover, Great spotted Cuckoo *Clamator glandarius* parasitized magpie nests based on nest size (Soler et al 1995), further experimentally demonstrated that magpie pairs selected by the Great spotted Cuckoo were of better parental quality than those not selected, because selected magpies raised more nestlings than did those not selected. Soler et al (2001) opined that magpipes females that paired with males that carried more stones to the nest laid earlier in the breeding season, resulting in a higher reproductive success in these females.

More protective and some what large sized nests containing large amount of nesting material, contained 4 eggs and rest of the nest contained less number of eggs in Brahminy Myna *Sturnus pagodarum*. We observed 5 nests of Indian robin of which 2 nests with 2 eggs and 3 nests with 3 eggs, but we could not concentrated to much about detailed study of this and various other birds.

It is generally accepted that individual birds adjust clutch size to their quality and /or to territory quality and that, within similar environments, greater ability to nourish the offspring should be associated with larger clutch size (Lack 1968, Saether 1994). However, clutch size could also be related to other factors such as predation risk or thermoregulatory properties of nest material. It is generally accepted that there is negative relationship between clutch size and risk of nest predation (Lima 1987). The roof of the magpie nest could affect the risk of nest predatron by making it difficult for predators to enter the nest and prey upon eggs to nestlings (Birkhead 1991).

Nests at low height in *S. pagodarum* and *Accipiter badius,* caused loss of eggs. In these cases high predation pressure was the major factor caused loss of eggs. Particularly in *A. badiuss* nest on *Tarmaridus indica* was observed at low height without dense leaves opened egg cover increased predation pressure due to improper selection of nesting site.

The males expression of sexually selected characters signaling parental quality should influence the females decision on when to start incubating (Gibbons 1987, Harper et al 1994, Wiebe and Bortolotti 1994). For a given clutch size, natural variation in the female decision of when to start incubation may reflect variation in parented quality, 'poor' parents or parents in a poor habitat may start incubation earlier in the laying sequence than ' good' parents (Gibbon 1987). This is because hatching time of a nestling in relation to that of its siblings is related to the probability of offspring survival and to offspring physical condition, not only as nestling (Bortolotti 1986, Zach 1982), but also after leaving the nest (Husby 1986), and hatching time is determined mainly by the amount of food the parents provide to the nestlings (Gibbons 1987).

Nests containing eggs of Indian peafowl *Pavo cristatus* Jungle Bush–Quail *Perdicula asiatica*, Little brown Dove *Streptopelia senegalensis*, Tailor bird *Orthotornus sutorius*, Indian Robin, Red vented Bulbul *Pycnonotus cafer* were observed in a terrestrial habitat with large supply of food. These birds probably correlated the hatching of eggs with availability and abundance of food to fed the hatchlings as a result large reproductive success obtained.

However, because the decision of when to start incubation is potentially related to clutch size (Wiebe and Bortolotti 1994), eggs protection from adverse weather or other environmental factors affecting hatching ability (Arnold et al 1987, Veiga 1992).

Studies on incubation period of *Accipiter badius* showed variation during three years, in breeding season 2017, it was 34 days, in 2018 it was 36 days and in 2019 It was 38 days, probably this may be the cause showed variation of delayed incubation period in contrast to last year of the study period. Such variation also observed in *Sturnus pagodarum* incubation period, which was 21.4 + 2.72 (mean + SD) in 2017 and 23.0 + 2.61 in 2018 years of the study period.

At the beginning of the breeding season, a female may have an uncertain estimate of the quality of the territory in which she breeds her nest site, her mate, and even her own abilities (Amundsen and Slagsvold 1996). These conditions could vary among individuals from the same population, but also among years for the same individuals and could explain individual variation in the level of hatching asynchrony (Amundsen and Slagsvold 1996), which is primarily determined by the decision of when to start incubation in the laying sequence (Mock and Parker 1997), but also by clutch size. Nilsson (1993) demonstrated that marsh tit *Parus palustris* without experimental food supplementation started to incubate earlier in the laying sequence than with food supplementation. His explanation was that asynchronous broods imply that female have to incubate, but also produce and lay eggs, two activities that are very costly and although an early start of incubation may be advantageous during the nestling period, they were forced to delay the onset of incubation.

However, Wiebe and Bortolotti (1994) hypothesized that some species should facultatively start incubation later in the laying sequence when supplemental food is provide during the prelaying period. This is because on of the main costs of the early start of incubation is that small nestlings may die from starvation or trampling, even when food is abundant (Amundsen and Slagsvold 1991).

During three year study period no any died young one observed in the area particularly during breeding season of Brahminy Myna *Sturnus padgodarum, d*ue to abundance of food material in the habitat, low predation pressure and low disturbance by anthropogenic activities resulted into high breeding success. Whereas in Indian Shikra *Accipiter badius* due to high predation pressure of House Crow *Corvus splendens*, Jungle Crow *Corvus macrorhychos* and Black Kite *Milvus migrans* and environmental hazards such as wind current, high rain fall on some days, resulted into low reproductive success, although there was abundance of food supply in the nesting area during breeding season of *Accipiter badius*.

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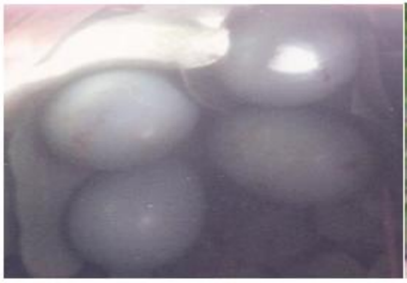

1. Eggs of Sturnus pagodarum

2. Eggs of Accipiter badius

3. Eggs of Pavo cristatus

4. Eggs of Pycnonotus cafer

5. Eggs of Saxicoloides fulicata

6. Eggs of Vanellus malabaricus

Fig. Clutch size of different birds from the area.